SEE FOLLOWING NOTE

VOIR NOTE CI-APRÈS

PARTS OF THE ORIGINAL DOCUMENT ARE OF POOR REPRODUCTIVE QUALITY.

MICROMEDIA LIMITED HAS ATTEMPTED TO PRODUCE THE BEST POSSIBLE COPY.

CERTAINES PARTIES DU DOCUMENT ORIGINAL SONT DE PIÈTRE QUALITÈ DE REPRODUCTION.

MICROMEDIA LTEE A ESSAYEE DE PROCURER LE MEILLEUR EXEMPLAIRE POSSIBLE.

[redacted]

Alberta

MUNICIPAL AFFAIRS

Innovative Housing Grants Program

COST STUDY OF SPRINKLER INSTALLATION FOR RESIDENTIAL HOUSING

October 1989

Prepared by:

JOHN C. WIEBE, P. ENG.
WIEBE FOREST ENGINEERING LTD.

The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of Alberta Municipal Affairs.

With funding provided by
Alberta Municipal Affairs

ISBN: 0-88654-254-5

90-02193/

FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

The Program offers assistance to builders, developers, consulting firms, professionals, industry groups, building products manufacturers, municipal governments, educational institutions, non-profit groups and individuals. At this time, priority areas for investigation include building design, construction technology, energy conservation, site and subdivision design, site servicing technology, residential building product development or improvement and information technology.

As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

Innovative Housing Grants Program
Alberta Municipal Affairs
Housing Division
Research and Development Section
16th Floor, CityCentre
10155 - 102 Street
Edmonton, Alberta
T5J 4L4

Telephone: (403) 427-8150

TABLE OF CONTENTS

LIST OF TABLES ii
EXECUTIVE SUMMARY iii

1.0 INTRODUCTION 1

2.0 STUDY IMPLEMENTATION 4

3.0 STUDY FINDINGS. 7

4.0 CONCLUSIONS 14

LIST OF REFERENCES AND SELECTED REFERENCE MATERIALS 15

APPENDIX A: DRAWINGS OF TYPICAL NEW ALBERTA HOME

APPENDIX B: TECHNICAL DRAWINGS OF SPRINKLER & SMOKE ALARM SYSTEMS

APPENDIX C: SPECIFICATIONS FOR SPRINKLER AND SMOKE ALARM SYSTEMS

LIST OF TABLES

Table 1: Additional Cost Charges for Water Service to Site: Urban Areas 7

Table 2: Typical Single Family Residential Water Services in Alberta 8

Table 3: Summary of Water Service Costs: Urban Areas. 9

Table 4: Additional Cost of Fire Water Service for Rural Areas 10

Table 5: Sprinkler System Costs. 11

Table 6: Total Cost Summary for Sprinkler Systems. 12

Table 7: Cost Summary for Smoke Alarm Systems. 13

EXECUTIVE SUMMARY

The purpose of this study was to provide realistic costs of installing sprinklers in single family housing. In addition, costs for installing smoke alarms were also provided for reference.

The cost estimates pertain to installing sprinklers and smoke alarms during construction of a typical new 140 square metre side-split residence in Alberta. The sprinkler system was designed to standard NFPA 130 which requires the sprinklering of the basement; consequently the total sprinklered area is 180 sq. m. or 1940 sq. ft. rather than the 140 sq m or 1506 sq. ft. normally quoted as the house size. This is reflected in the sq. m costs. The study scope included:

1) a wet sprinkler system designed in accordance with NFPA 13D,
2) an alternate wet sprinkler system designed to provide protection for the most hazardous areas based on a review of Alberta fire statistics,
3) an interconnected hard wired smoke alarm system designed to NFPA 74 standards, and
4) an alternate interconnected hard wired smoke alarm system designed to provide protection for the most hazardous areas based on a review of Alberta fire statistics.

Detailed information is documented in the tables included in the report. The main study findings are noted below:

COST ANALYSIS SUMMARY
(180 Sq.M - 1940 Sq.Ft.)

		URBAN LOCATION		RURAL LOCATION	
		Cost	Cost/m2	Cost	Cost/m2
.1	Sprinkler System To NFPA 13D				
	High Cost	$4,599.00	$25.55	$7,125.00	$39.58
	Low Cost	$2,779.00	$15.44	$4,792.00	$26.62
	Average Cost	$3,924.00	$21.80	$6,313.00	$35.07
.2	Modified Sprinkler System				
	High Cost	$3,131.00	$17.39	$6,260.00	$34.78
	Low Cost	$1,985.00	$11.03	$4,407.00	$24.48
	Average Cost	$2,722.00	$15.12	$5,647.00	$31.37
.3	Smoke Alarm System To NFPA 13D				
	High Cost	$756.00	$4.20	No detailed quotes were obtained, but indications from contractors are that rural costs would be approximately 10% higher.	
	Low Cost	$358.00	$1.99		
	Average Cost	$490.60	$2.73		
.4	Modified Smoke Alarm System				
	High Cost	$486.00	$2.70		
	Low Cost	$224.00	$1.24		
	Average Cost	$319.20	$1.77		

CONCLUSIONS:

In reviewing the Cost Analysis Summary, it becomes obvious that the cost impact of sprinkler systems for residential housing is very significant and this significance cannot be ignored when debating the issue of mandatory sprinkler systems for residential housing.

1.0 INTRODUCTION

1.1 PURPOSE

A national debate is currently under way regarding the appropriateness of mandating the installation of fire sprinklers in single family residences.

The outcome of the debate will affect the adoption of regulations on mandatory requirements for sprinklers which will, in turn, have an impact on the cost and safety of housing. To date, this debate has been hampered by the lack of reliable information concerning the costs which could be anticipated for installing fire sprinklers, or related technologies such as smoke alarms, on a broad basis in Alberta's rural and urban single family residences.

The purpose of this study was to respond to the lack of information and establish realistic cost estimates reflecting the costs that would be incurred if fire sprinklers were mandatory for all new single family residences in both rural and urban locations in Alberta. The study also estimated the costs of installing smoke alarms in new houses to provide reference information on these fire protection measures for comparison purposes.

This report documents the results of the study. The information is intended to help the parties involved in this debate resolve the costs and benefits of alternative fire protection technologies in general and of mandatory sprinkler regulations in particular.

1.2 PROJECT PARAMETERS

The costs are based on the costs of incorporating sprinklers during the construction of a new conventional 140 square metre single family residence in the Province of Alberta, as shown in Appendix A.

The house plan used in this project is one currently used by Alberta Municipal Affairs in its annual "House Cost Comparison Study". The plan was developed after extensive research and reflects the type of new home that is generally being built in Alberta and which might be described as a three bedroom back-split. It was felt that the costs related to work involving this home would be representative of the typical costs which would be encountered within the Province.

The sprinkler system was designed to standard NFPA 130 which requires the sprinklering of the basement; consequently the total sprinklered area is 180 sq. ft. normally quoted as the house size. This is reflected in the sq. m costs.

In order to establish comprehensive costing information for sprinkler systems, the following approach was adopted:

.1 One residential sprinkler system was designed to the recognized Standard NFPA 13D and costed.

.2 An alternate residential sprinkler system was developed to respond to critical areas of a residence based on evaluation of fire statistics and costed.

.3 Costs for combined service for both domestic water and sprinkler system were costed based on information obtained from the cities of Red Deer and Calgary.

.4 The additional cost of providing water storage and pressure pumping facilities to meet the minimum water requirements of NFPA 13D for sprinkler systems in rural locations served by private well systems with limited flow capacity were costed.

.5 An alternative smoke alarm system installed to the recognized Standard NFPA 74 was designed and costed.

.6 An alternative smoke alarm system installed to cover the most critical areas of a residence based on evaluation of fire statistics was costed.

In order to obtain the most reliable and realistic pricing, drawings and specifications were developed in a manner normally used for tender pricing of projects. These were issued to mechanical and electrical contractors who acted as paid consultants to do quantity takeoffs and tender prices. These prices are based on current procedures normally established in the Building Industry.

Contractors contacted in Calgary (2) and Red Deer (1) elected to bid either plastic or copper systems depending on which material they deemed to be most cost effective. A fourth, independent sprinkler contractor submitted design-build prices based on his own layouts and material selections. The following chart identifies the contractors by location and system:

INFORMATION ON SPRINKLER CONTRACTORS

Contractor	Location	Piping Material
A	Calgary	Copper Piping
B	Calgary	Plastic Piping
C	Red Deer	Copper Piping
D	Price based on Design and Install Basis by an Independent Sprinkler Contractor	

2.0 STUDY IMPLEMENTATION

The project commenced with a review of applicable codes and standards to establish a basis for the design and costing of sprinklers and smoke alarm system.

.1 Sprinkler Systems:

The Alberta Building Code 1985 does not require mandatory sprinklering of single family residences and therefore does not set out minimum installation requirements for single family residential sprinkler systems.

In the absence of a comparable Canadian standard, most of the sprinkler industry has adopted the American standard NFPA 13D, "Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes" which provides "a method for those individuals wishing to install a sprinkler system for additional life safety and property protection". It is not the purpose of this standard "to require the installation of an automatic sprinkler system". The standard further assumes that one or more smoke detectors (alarms) will be installed in accordance with NFPA 74.

NFPA 13D was therefore assumed to be the standard that would form the basis of any mandatory sprinkler installation and therefore was chosen as the basis for the costing study. Figures M-1 and ME-1 of Appendix B contain the plans for the sprinkler system designed to the NFPA 13D standard.

As noted, the study also investigated the cost of a sprinkler system with reduced coverage from NFPA 13D but which would provide protection for critical areas of the building. These critical areas were established on the basis of a review of provincial fire statistics and reports.

A report from Alberta Labour's Fire Protection Branch entitled "Residential Fires: Places and Corners of Danger" indicates that the areas of origin of most fires in residences are kitchens 35%, living room areas 13%, and bedrooms 10% for a total of 58% of all fires. The major causes of fire fatalities are kitchens 11%, living room areas 52%, and bedrooms 7% for a total of 70% of all fire fatalities.

The figures suggest that the most critical areas with respect to life safety are kitchens and living room areas. This conclusion is echoed in "Home Fires by Major Areas of Origin 1987" which provides essentially the same information; namely, that kitchens and living rooms are where the greatest number of fatalities occur.

Therefore, based on this information, it was decided to design and cost a second modified system which covered only those hazardous areas, i.e. kitchens and living room/family rooms. The plans for the modified sprinkler system are contained in Figures ME-1 and M-2 of Appendix B.

.2 Smoke Alarm Systems

The Alberta Building Code 1985 calls for and establishes a minimum standard for a smoke alarm system in single family dwellings. NFPA 74, "Standard for the Installation, Maintenance and Use of Household Fire Warning Equipment" establishes, we believe, an acceptable standard for a comprehensive smoke alarm system which parallels the NFPA 13D standard for sprinkler systems and was therefore chosen as the basis for the design and costing of smoke alarm systems. A smoke alarm system designed to NFPA 74 is detailed on Figure E-2 of Appendix B.

As with the sprinkler system, it was decided to design and cost a modified smoke alarm layout on the basis of protecting the most hazardous areas. Reference materials suggested that it might be advisable to add smoke alarms in the living room/family room area but not in the kitchen. The kitchen was excluded to eliminate nuisance alarms, and the belief that any significant amount of smoke in the kitchen would likely activate smoke alarms in nearby areas. A modified smoke alarm system is noted on Figure E-1 of Appendix B.

3.0 STUDY FINDINGS

This section presents key findings related to the study objectives. Table 1 outlines those additional charges levied by the City or Developer to provide the noted service size to the property line.

TABLE 1

ADDITIONAL COST CHARGES FOR WATER SERVICE TO SITE: URBAN AREAS

Location	50mm Service	38mm Service
City of Calgary	$550.00	$500.00
City of Calgary, Subdivision Contractor	$700.00	$600.00
City of Red Deer	$700.00	$220.00
AVERAGE COST	$650.00	$440.00

Table 2 is a compilation of the average service line size and the corresponding water pressure to be found in a representative sample of Alberta communities.

TABLE 2

TYPICAL SINGLE FAMILY RESIDENTIAL WATER SERVICES IN ALBERTA

Location	Size of Service mm	(in)	Avg. Pressure kPa	(psi)	Pressure Range kPa	(psi)
Calgary	19	(3/4")	483	(70)	275-690	(40-100)
Carstairs	19	(3/4")	414	(60)	345-448	(50-65)
Claresholm	19	(3/4")	414	(60)	----	
Cochrane	19	(3/4")	552	(80)	276-827	(40-120)
Didsbury	19	(3/4")	448	(65)	----	
Edmonton	19	(3/4")	345	(50)	380-414	(55-60)
Grand Prairie	19	(3/4")	414	(60)	----	
Lloydminster	19	(3/4")	414	(60)	----	
Medicine Hat	19	(3/4")	414	(60)	241-759	(35-110)
Strathmore	19	(3/4")	414	(60)	207-414	(30-60)
Sylvan Lake	19	(3/4")				
Taber	19	(3/4")	380	(55)	345-414	(50-60)

Table 3 outlines the costs quoted by the three mechanical contractors for providing 14 meters of 50 mm, 38 mm or 19 mm service line from the property line to the residence. The required service line size will be determined by the available water pressure at any specific site and reflects the need to use larger diameter pipe to maintain an adequate line pressure in areas of low supply.

Prices have been quoted for the three line sizes in order to facilitate an easy comparison of the resultant servicing costs. The table also includes the average service upcharge noted in table 1 plus an allowance of 20% for overhead and profit.

TABLE 3

SUMMARY OF WATER SERVICE COSTS: ON SITE IN URBAN AREAS

	Service Cost			Incremental Cost of Service	
	50 mm	38 mm	19 mm	50 mm	38 mm
Contractor A					
- Service	$ 995.	$ 703.	$ 450.		
- City Charge	650.	440.	-0-		
Subtotal	$1,645.	$1,143.	$ 450.		
- OH & Profit	329.	228.	90.		
	$1,974.	$1,371.	$ 540.	$1,434.	$ 931.
Contractor B					
- Service	$1,084.	$ 938.	$ 772.		
- City Charge	650.	440.	-0-		
Subtotal	$1,734.	$1,378.	$ 772.		
- OH & Profit	260.	207.	116.		
	$1,994.	$1,585.	$ 888.	$1,106.	$ 697.
Contractor C					
- Service	$1,298.	$1,032.	$ 845.		
- City Charge	650.	440.	-0-		
Subtotal	$1,948.	$1,472.	$ 845.		
- OH & Profit	195.	147.	84.		
	$2,143.	$1,619.	$ 929.	$1,214.	$ 690.
AVERAGE ADDITIONAL COST OF WATER SERVICE ON SITE IN URBAN AREAS.				$1,251.	$ 739.

As noted in Chapter 1, the study also investigated the implications of installing an NFPA 13D system in a rural setting which is serviced by a well. The system design is shown on drawing ME-1 in Appendix B. Table 4 below estimates the upcharge for the tank and pump which are required on such a rural system.

TABLE 4

ADDITIONAL COST OF FIRE WATER SERVICE FOR RURAL AREAS

	Contractor Cost			
	A	B	C	Average Cost
Water Storage Tank and Pump	$3,300.	$2,712.	$3,376.	
OH and Profit	660.	407.	331.	
	$3,960.	$3,119.	$3,707.	$3,595.

Table 5 compares the cost of the NFPA 13D and the modified sprinkler system as supplied by the four contractors.

TABLE 5

SPRINKLER SYSTEM COSTS

	Contractor Cost				Average
	A	B	C	D	Cost
Sprinkler System To NFPA 13D	$2,270.	$1,455.	$2,677.	$ -	
OH and Profit	454.	218.	267.	-	
TOTAL COST	$2,724.	$1,673.	$2,944.	$3,165.	$2,627.
Modified Sprinkler System	$1,620.	$1,120.	$2,099.	$ -	
OH and Profit	324.	168.	209.	-	
TOTAL COST	$1,944.	$1,288.	$2,308.	$2,300.	$1,960.

**Please refer to Information on Sprinkler Contractors on Page 3.

Table 6 summarizes the information provided in the four tables and derives an average cost for standardized and modified sprinkler systems in both rural and urban settings. Whereas the required service size is a function of available municipal water pressure, prices are provided for both a 50 mm and 38 mm service line.

TABLE 6

TOTAL COST SUMMARY FOR SPRINKLER SYSTEMS*

	Contractor Cost: Urban Areas				Avg.	Avg.Cost
	A	B	C	D	Cost	per sq.m
Sprinkler System To NFPA 13D	$2,724.	$1,673.	$2,944.	$3,165.	$2,627.	
50mm Wtr Service	1,434.	1,106.	1,214.	1,434.	1,297.	
TOTAL COST	$4,158.	$2,779.	$4,158.	$4,599.	$3,924.	$21.80
Modified Sprinkler System	$1,944.	$1,288.	$2,308.	$2,300.	$1,960.	
38mm Wtr Service	831.	697.	690.	831.	762.	
TOTAL COST	$2,775.	$1,985.	$2,998.	$3,131.	$2,722.	$15.12

	Contractor Cost: Rural Areas				Avg.	Avg.Cost
	A	B	C	D	Cost	per sq.m
Sprinkler System To NFPA 13D	$2,724.	$1,673.	$2,944.	$3,165.	$2,627.	$14.59
Water Storage Tank and Pump	3,960.	3,119.	3,707.	3,960.	3,686.	
TOTAL COST	$6,684.	$4,792.	$6,651.	$7,125.	$6,313.	$35.07
Modified Sprinkler System	$1,944.	$1,288.	$2,308.	$2,300.	$1,960.	
Water Storage Tank and Pump	3,960.	3,119.	3,707.	3,960.	3,687.	
TOTAL COST	$5,904.	$4,407.	$6,015.	$6,260.	$5,647.	$31.37

* These costs do not include the cost of a smoke alarm system as required by NFPA 13D standards in conjunction with Fire Alarm Systems.

Table 7 compares the estimates for the installation of a standardized NFPA 74 smoke alarm system and a modified system which concentrates on protecting the areas of highest fire risk. All figures include an allowance of 20% for overhead and profit.

TABLE 7

COST SUMMARY FOR SMOKE ALARM SYSTEMS

	Contractor Cost					* Avg.
	A	B	C	D	E	Cost
Smoke Alarm System to NPFA 74	$630.	$316.	$480.	$286.	$ -	
OH and Profit	126.	47.	48.	72.	-	
TOTAL COST	$756.	$363.	$528.	$358.	$448.	$490.60
Modified Smoke Alarm System	$405.	$287.	$250.	$225.	$ -	
OH and Profit	81.	43.	25.	56.	-	
TOTAL COST	$486.	$330.	$275.	$281.	$224.	$319.20

4.0 CONCLUSIONS

The study concluded that the cost of sprinklering a new Alberta home to a nationally recognized standard such as NFPA - 13D would average nearly $4,000 in a rural setting and about $6,300 more in rural areas. While these figures are in themselves considerable, the reader should recall that they do not include any allowance for the general contractors' overhead and profit which could easily add an additional 10% to the cost of the installed systems.

Readers outside Alberta should note that at the time of writing, the Province had one of the lowest construction cost indices in Canada.

LIST OF REFERENCES AND SELECTED REFERENCE MATERIAL

1. Alberta Building Code - 1985.

2. NFPA 13D - "Standard for the Installation of One- and Two-Family Dwellings and Mobile Homes".

3. NFPA 74 - "Standard for the Installation, Maintenance and Use of Household Fire Warning Systems".

4. "Fire Commissioner's Statistical Report" - 1987,
   Published by Alberta Labour,
   General Safety Services Division,
   Fire Prevention Branch. (Pages 16, 17, 18)

5. "Residential Fires: Places and Cause of Danger"
   Commentary by W.D. (Bill) MacKay, Fire Commissioner,
   Fire Prevention Branch, Alberta Labour
   Published by the Canadian Association of Fire Chiefs
   1590 - 7 Liverpool Court, Ontario, K1B 4L2
   Number 72, ISSN 0706-1382
   September 1987. (Pages 19, 20)

Home Fires by Major Ignition Scenarios – 1987

Area and Source of Ignition	Material First Ignited	Act or Omission	Percent Of All Fires In Area Of Origin – Source Of Ignition Incidents	Deaths	Injuries	$ Loss
Kitchen:						
Stove or range top burner area						
Fire in pan	Cooking oil	Overheated oil	14*	33	9	10
Fire in deep-fat fryer/pot	Cooking oil	Overheated oil	52	33	57	58
Structural Areas:						
Exposure fire from detached structure	Mainly exterior wall cover	Several	55	—	—	52
Electrical: wiring; distribution equip.	Insulation	Electrical Short Circuit	52	—	100	49
Fireplace	Wall structure	Installation deficiency	50	—	—	63
Match, lighter not used with smoking	Several	Arson	50	—	—	35
		Children playing	40	—	100	30
Living Room:						
Smoker's material	Upholstered furniture	Smoker's material**	72	75	64	71
Match, lighter not used with smoking	Carpet, rug, furnishings, paper products, clothing	Children playing	54	83	44	49
Fireplace	Carpet, rug	Human failing	47	—	—	12
Bedroom:						
Match, lighter not used with smoking	Carpet, rug, furnishings, paper products clothing	Children playing	71	—	75	58
		Arson	20	—	14	31
Smoker's material	Mattress, bedding	Smoker's material	58	50	60	47
		Asleep	6	—	—	1
		Impaired	10	—	13	3
Laundry Area:						
Clothes dryer	Fibres, lint, clothing textiles, fabrics, etc.	Ignorance of hazard	23	—	—	18
		Mechanical, electrical failure, malfunction	18	—	50	29
Heating Equipment Room:						
Central heating unit	Ceiling/covering, fuel oil, natural gas, propane, fibres, electrical/insulation	Mechanical, electrical failure, malfunction	31	—	38	21
	Clothing, paper, propane, oily rags	Ignorance of hazard	10	—	13	4
Service water heater	Clothing, cardboard, gasoline, flammable liquid, propane	Fuel: spilled; used for cleaning; too close to heat; improper storage; ignorance of hazard	48	—	50	53

– Continued on next page –

Home Fire Losses in Alberta – 1987

Type	Incidents	Deaths	Injuries	$ Loss
1 & 2 Family Dwellings	1,523	18	126	21,066,734
Mobile Home	179	6	22	3,393,893
Apartment, Tenement	491	13	58	2,994,237
Total	2,193	37	206	27,454,864

Home Fires by Major Areas of Fire Origin – 1987

Area of Origin	% Of Incidents	% Of Deaths	% Of Injuries	% Of $ Loss
Kitchen	35	19	32	19
Structural Area	14	3	3	15
Living Room	12	46	24	14
Bedroom	12	8	18	12
Laundry Area	5	0	3	2
Heating Equipment Room	4	3	10	7
Chimney	2	0	0	1
Other	16	21	10	30

Home Fires by Major Sources of Ignition – 1987

Area of Origin	Source of Ignition	Percent Of All Fires In Area Of Origin Incidents	Deaths	Injuries	$ Loss
Kitchen	Stove or range, top burner area	71	43	88	68
Structural Area	Exposure fires	25	—	—	17
	Electrical: wiring; distribution	18	—	20	21
	Fireplace	12	—	—	14
Living Room	Smoker's material*	36	24	51	34
	Match, lighter not used in smoking	14	35	18	12
	Fireplace	13	—	—	4
Bedroom	Match, lighter not used in smoking	32	—	22	31
	Smoker's material*	27	67	41	22
	Candle	8	—	11	10
	Incandescent lamp, Light bulb	7	—	3	2
Laundry Area	Clothes dryer	61	—	29	25
Heating Equip. Area	Central heating unit	46	100	38	42
	Service water heater	27	—	19	24
Chimney	Fireplace	71	—	—	19
	Match, lighter not used in smoking	22	62	10	8
	Smoker's material*	10	—	14	5

* Smoker's material includes cigarettes, pipe, cigar and/or matches, lighter used in conjunction with smoking.

Table 1. 1984 Fire Losses in Alberta, Canada and the U.S.

Region	Number of fires	Deaths	Injuries	$Losses (Millions)
Alberta	8,467	62	412	162
Canada	70,730	598	4,103	929
U.S.	2,343,000	5,240	28,125	6,707

Table 2. Major Areas of Fire Origin in One or Two Family Dwellings*

Area of Origin	Percent of All Areas of Fire Origin Incidents	Deaths	Injuries	$Losses
Kitchen	35	11	30	15
Structural Areas	16	–	4	17
Living Room	13	52	20	15
Bedroom	10	7	20	13
Laundry Area	5	–	3	7
Heating Equipment Room	4	–	8	1
Chimney	4	–	1	1
Other	13	30	14	27

*Based on 1,557 fires in one or two family dwellings during 1986 in Alberta. Total number of deaths, injuries and dollar losses from these fires were 27,129 and 22.9 million.

Table 3. Major Sources of Ignition in One or Two Family Dwellings in Alberta (1986)

Area of Origin	Source of Ignition	Percent of All Fires in Area of Origin Incidents	Deaths	Injuries	$Losses
Kitchen	Stove or range, top burner area	68	33	67	59
Structural Areas	Fireplace	18	–	–	32
	Electrical: wiring; distribution	15	–	–	20
	Exposure fires	14	–	–	5
Living Room	Smokers' material*	34	86	42	42
	Fireplace	17	–	–	4
	Match, lighter not used with smoking	12	–	15	10
Bedroom	Smokers' material	31	100	35	22
	Match, lighter not used with smoking	27	–	35	25
Laundry Area	Clothes dryer	54	–	–	7
Heating Equipment Room	Central heating unit	49	–	20	34
	Service water heater	22	–	50	14
Chimney	Fireplace	69	–	100	69

*Smoker's material includes cigarettes, pipe, cigar and/or matches, lighter used in conjunction with smoking.

Table 4. Major Ignition Scenarios in One or Two Family Dwellings in Alberta (1986)

Area & Source of Ignition	Material First Ignited	Act or Omission	Percent of All Fires in Area — Source of Ignition Incidents	Deaths	Injuries	$Losses
Kitchen:						
Stove or range, top burner area						
Fire in pan	Cooking oil	Overheated oil	24*	–	19	25
Fire in deep-fat fryer/pot	Cooking oil	Overheated oil	40	100	31	44

Table 4. Major Ignition Scenarios in One or Two Family Dwellings in Alberta (1986) (cont'd.)

Area & Source of Ignition	Material First Ignited	Act or Omission	Percent of All Fires in Area — Source of Ignition Incidents	Deaths	Injuries	$Losses
Structural Areas:						
Fireplace	Wall, structure	Installed too close to combustible	17	–	–	11
		Other design, installation deficiency	19	–	–	13
	Floor, ceiling, roof structure	Design, installation deficiency	19	–	–	18
Electrical: wiring, distribution equip.	Insulation	Electrical short circuit	65	–	–	46
Exposure fire from detached structure	Exterior wall cover	Several	74	–	–	95
Living Room:						
Smoker's material	Upholstered furniture	Smoker's material**	71	100	55	78
Fireplace	Carpet, rug	Ignorance of hazard	49	–	–	13
Match, lighter	Carpet, rug, furniture, furnishings, paper products, trash, etc.	Children playing	88	–	100	67
Bedroom:						
Smoker's material	Mattress, pillow, bedding	Smoker's material	38	50	22	32
		Asleep	17	–	–	3
		Impaired	6	–	11	5
	Carpet, rug, furniture, clothing, paper, trash, etc.	Smoker's material	27	50	11	25
Match, lighter	Carpet, rug, mattress, pillow, bedding, clothing, paper, etc.	Children playing	90	–	100	85
Laundry Area:						
Clothes dryer	Fibres, lint	Ignorance of hazard	19	–	–	13
	Clothing, textiles, fabric, etc.	Mechanical, electrical failure, malfunction	69	–	–	84
Heating Equipment Room:						
Central heating unit	Floor cover, structural components, natural gas, electric insulation, trash, etc.	Mechanical, electrical failure, malfunction	44	–	–	30
	Flammable, combustible liquids/gases, trash, clothing, fabric	Ignorance of hazard	14	–	50	2
Service water heater	Flammable liquids, gasoline, kerosene, etc.	Fuel: spilled, used for cleaning, improperly stored Ignorance of hazard	47	–	100	66
Chimney:						
Fireplace	Tar	Ignorance of hazard	93	–	100	100

*Interpreted as follows: 24% of all fires in the kitchen — stove or range top burner area were from the ignition of cooking oil in pans, as a result of overheating
**Misuse of smoker's material

CAFC DIALOGUE

Published by
CANADIAN ASSOCIATION OF FIRE CHIEFS INC. 1590-7 LIVERPOOL COURT, OTTAWA, ONT. K1B 4L2

NUMBER 72 ISSN 0706-1382 SEPTEMBER 1987

RESIDENTIAL FIRES: PLACES & CAUSES OF DANGER

Commentary: W.D. (Bill) MacKay
Fire Commissioner, Fire Prevention Branch
Alberta Labour
Edmonton, Alberta T5K 0G2

Residential fires account for a large proportion of incidents, deaths, injuries and property damage due to fire in North America. The prevention of and protection from these fires are indeed serious challenges to all of us in the fire service, as well as to the general public. Too often, details of residential fires are unavailable because they are embedded in statistics on the overall fire situation. As such, home fire safety programs that must necessarily address specific fire problems are short changed.

This article will attempt to assess the residential fire problem at two levels. First, with an overview of the significance of the problem in the context of the total fire situation. Second, with a top-down analysis to subdivide the large mass of residential fire loss data into the leading areas of fire origin and their major sources of ignition, followed by construction of major ignition scenarios for each area. It is hoped that the identification of the places and causes of fire danger in this manner will provide a sound basis for consideration of a variety of strategies to attack the problem.

An Overview

According to 1984 fire loss statistics (Table 1), for which comparative data are available from Alberta, Canada and the United States, residential fires (one or two family dwellings, apartments, and mobile homes) accounted on the average for 33% of all fires, 77% of fire fatalities and 59% of fire injuries in all three regions. Dollar losses for the same period, in the three regions respectively, were 17, 36 and 50% of the total fire losses. These statistics share in common the fact that the greatest danger from fire is in the home. They also indicate an urgent need to apply more effort to our residential fire prevention and protection programs.

Top-down Analysis of Residential Fires

The majority of home fires in North America occur in one or two family dwellings. Accordingly, the top-down analysis deals with this property class. Where results differed from those of apartments and mobile homes, comment is provided. Due to availability and easy access, data from the Alberta Fire Prevention Branch was used for analysis. In a general sense, it is assumed that information from Alberta is applicable to the rest of Canada.

Areas of Fire Origin & Sources of Ignition

Table 2 outlines the leading areas of fire origin in one or two family dwellings. In terms of the number of incidents, the ranking of areas of fire origin, from most to least frequent, for apartments is: (1) kitchen, (2) bedroom, (3) living room, (4) means of egress, (5) structural areas, (6) laundry area, (7) heating equipment room. For mobile homes the ranking is: (1) structural areas, (2) kitchen, (3) bedroom, (4) heating equipment room, (5) living room, (6) means of egress, (7) laundry area. The kitchen is the primary area of fire origin in the majority of Alberta homes.

Analysis of residential fires in Alberta, from 1981 to 1986, revealed the following percentage distribution of fire deaths by area of fire origin: living room (36.5%), kitchen (21.4%), bedroom (18.3%), and heating equipment room (6.9%); and of fire injuries by area of fire origin: kitchen (30.4%), living room (20.4%), bedroom (20.2%), and heating equipment room (6.4%). These findings agree with those in Table 2, and indicate that although most home fires start in the kitchen and that these inflict most fire injuries, the "real killer" fires start in the living room.

Table 3 indicates the major sources of ignition in the leading areas of fire origin. The most common sources of ignition are the stove or range top burners, smoker's material, the fireplace, and matches or lighters. Smoker's material accounted for 86% and 100% of fatal living room and bedroom fires. Stove or range top burners accounted for 67% of all kitchen fire injuries.

Ignition Scenarios

After fires were sorted on the basis of area of origin, major ignition scenarios were constructed for each of the leading

areas. The three dimensions used in the construction of ignition scenarios were the source of heat or ignition, fuel or material first ignited and the human behaviours (termed acts or omissions for statistical classification) that brought them together. Table 4 shows the major ignition scenarios. An attempt was made to structure this information in a way that would help locate problems more specifically for the design of appropriate prevention strategies. For example, children playing is the most frequent (90%) act or omission in living room and bedroom fires that were started with matches or lighters.

The four leading fire problems in one or two family dwellings in Alberta (Table 4) are: (1) overheated cooking oil catching fire in a pan, deep-fat fryer or pot, heated on a stove or range top burner, in the kitchen; (2) smoker's material igniting upholstered furniture in a living room or bedding and other material in a bedroom; (3) fireplace related fires in structural areas, in living rooms and in chimneys; and (4) children playing with matches or lighters, and setting fire to a variety of combustible materials in the living room and bedroom. Due to limitation of space and the self explanatory nature of the data tables, further discussion of ignition scenarios will not be attempted. However, note must be made of a difference encountered in the analysis of structural area fires in mobile homes. Analysis of mobile home fires between 1984-1986 indicated that structural area fires were primarily in the substructure and that these were mostly the result of attempts to thaw frozen utility lines with open flames or space heaters.

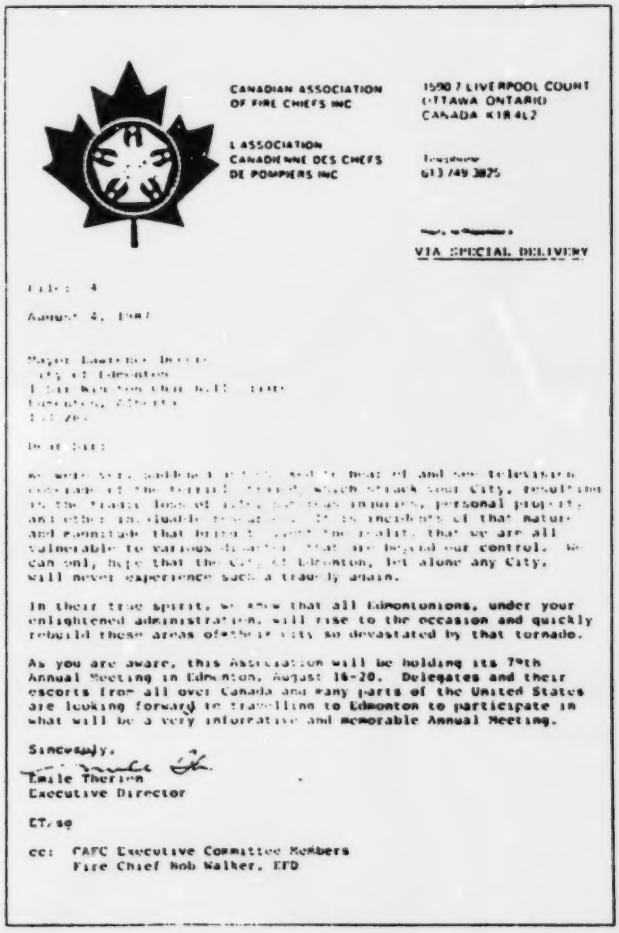
Discussion

Although the top-down analysis and the ignition scenarios enable stratification of the fire loss data into several dimensions, this information alone is not sufficient for the design of strategies to address the leading fire problems. We must probe deeper to gain an indepth understanding of the various factors and circumstances that bring about these fires. "Cooking safely with fats and oils", the major theme of our 1987 fire prevention week campaign can be used to illustrate this point. Cooking oil fires top the list of residential fires in Alberta. We therefore conducted an indepth analysis of these fires and prepared a research paper entitled, "A Report on Cooking Oil Fires in Alberta Residences". The key finding in this report is that most of these fires start as a result of overheating oils above their flashpoints, due to lack of temperature control. This bears significance in view of the generally used slogan, "put a lid on grease fires". Although this is a correct response during such fires, the prevention of these fires, by the use of thermostatically controlled deep-fat fryers and by other means, has largely been overlooked in the past. It is obvious that public education programs must address the key causes to achieve a substantial long term reduction of these fires. This consideration has formed the basis for the development of a pamphlet and a video program on cooking safely with fats and oils, to be distributed during our October campaign. Our research also indicates that most cooking oil fires are detected personally and within moments of ignition. This is encouraging in terms of fire safety education because the target audience would be normally awake and functioning when cooking oil fires occur. We are optimistic that the campaign will have a favourable impact on our fire statistics.

Conclusions

The major fire problems identified in this article are not new, and have dominated the residential fire scene for a long time. Although various prevention programs over the years have helped prevent fires, the residential fire problem still remains a real challenge.

Our current prevention strategies must be refined further to address specific factors that are responsible for the leading fire problems. The top-down analysis of fire loss data can show us the leading problems. Beyond that, however, it becomes necessary to probe each fire problem to the last possible detail and to use this information judiciously, if we are to minimize the residential fire problem.



CANADIAN ASSOCIATION OF FIRE CHIEFS INC

L'ASSOCIATION CANADIENNE DES CHEFS DE POMPIERS INC

1590 7 LIVERPOOL COURT
OTTAWA ONTARIO
CANADA K1R 4L2

613 749 3875

VIA SPECIAL DELIVERY

File: 4

August 4, 1988

Mayor Lawrence Decore
City of Edmonton
1 Sir Winston Churchill Sq
Edmonton, Alberta
T5J 2R7

Dear Sir:

We were very saddened to hear of and see television coverage of the horrific tragedy which struck your City, resulting in the tragic loss of life, personal injuries, personal property, and other irreplaceable losses. It is incidents of that nature and magnitude that bring it home to realize that we are all vulnerable to various disasters that are beyond our control. We can only hope that the City of Edmonton, let alone any City, will never experience such a tragedy again.

In their true spirit, we know that all Edmontonians, under your enlightened administration, will rise to the occasion and quickly rebuild these areas of their city so devastated by that tornado.

As you are aware, this Association will be holding its 79th Annual Meeting in Edmonton, August 16-20. Delegates and their escorts from all over Canada and many parts of the United States are looking forward to travelling to Edmonton to participate in what will be a very informative and memorable Annual Meeting.

Sincerely,

Emile Therien
Executive Director

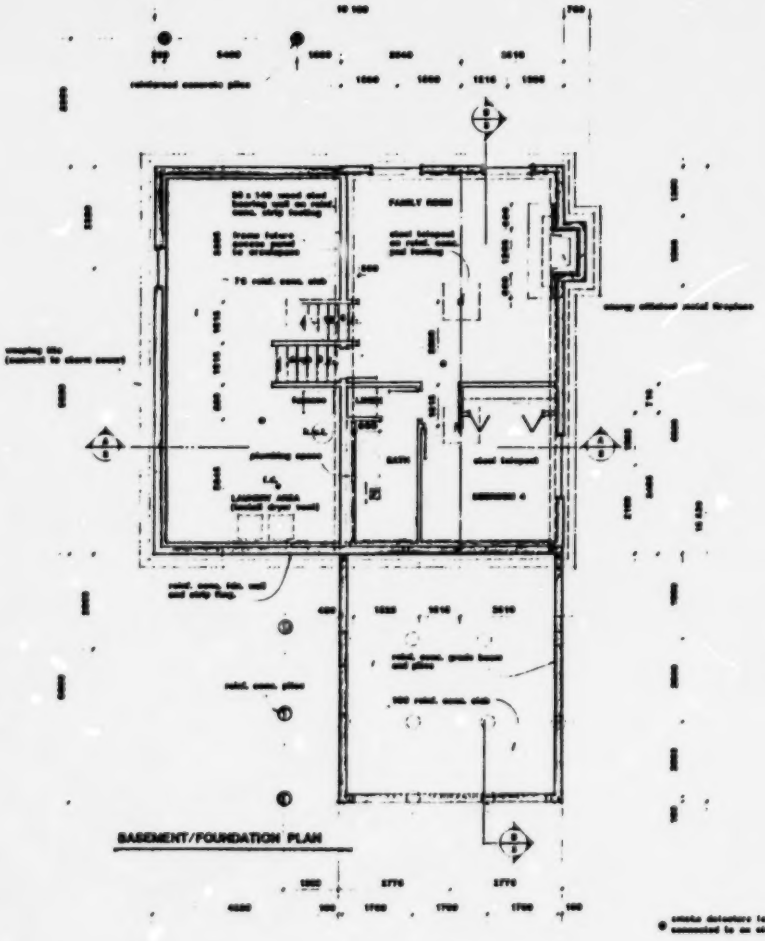
ET/sg

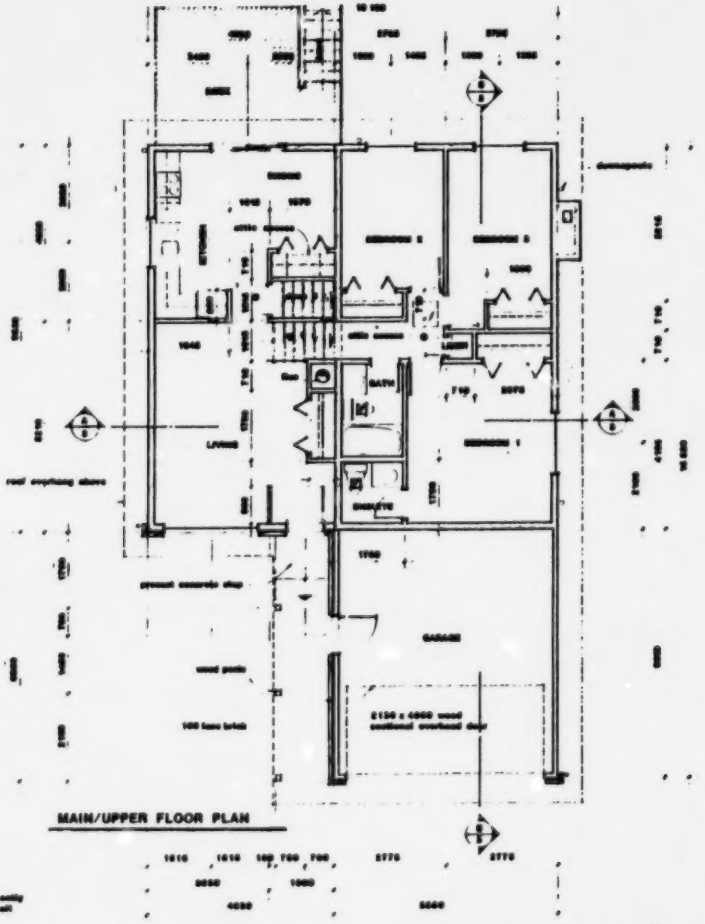
cc: CAFC Executive Committee Members
Fire Chief Bob Walker, EFD

APPENDIX A

DRAWINGS OF TYPICAL NEW ALBERTA HOME

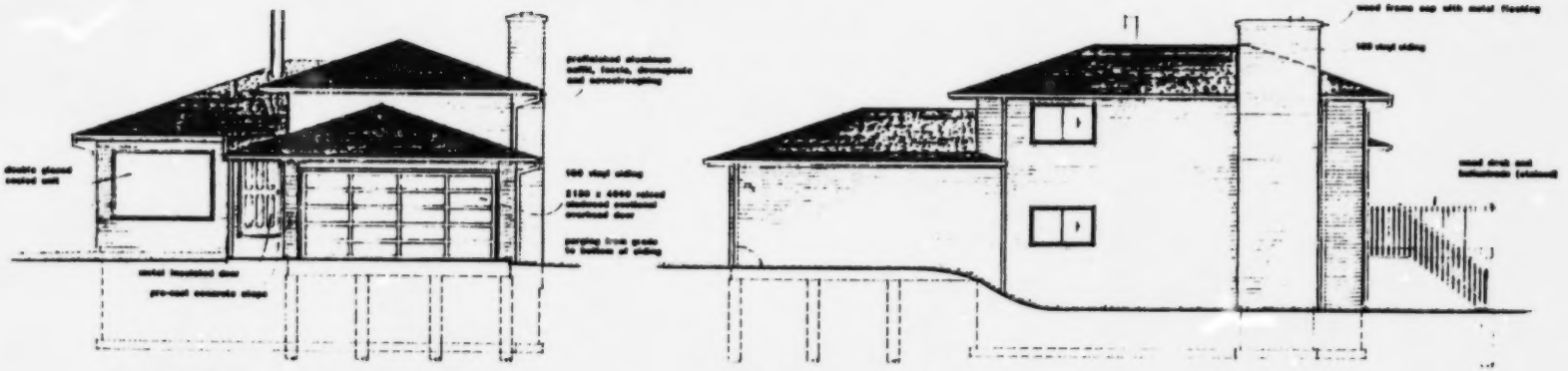
Drawing 1:	Floor Plans
Drawing 2:	Exterior Elevations
Drawing 3:	Building Cross Sections and Notes





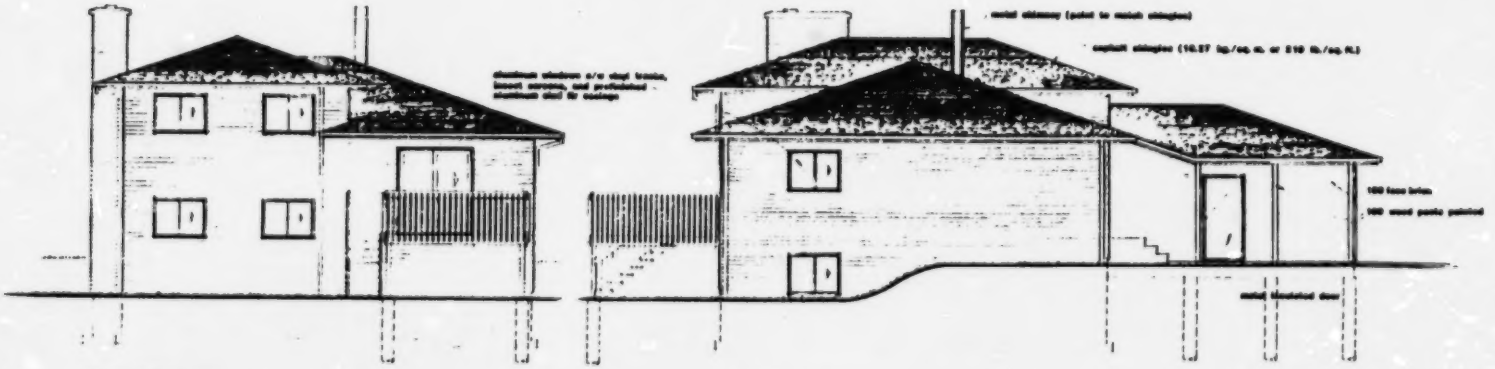
A - 2

1 OF 3



FRONT ELEVATION

RIGHT SIDE ELEVATION

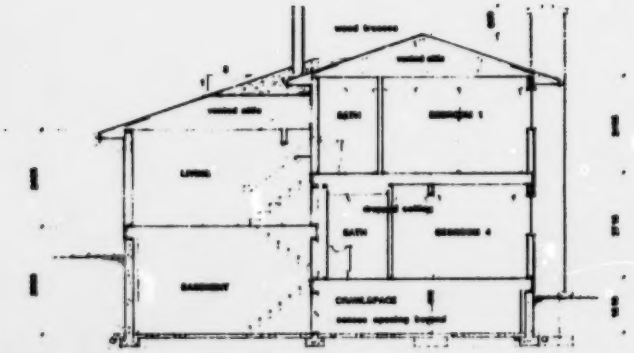


BACK ELEVATION

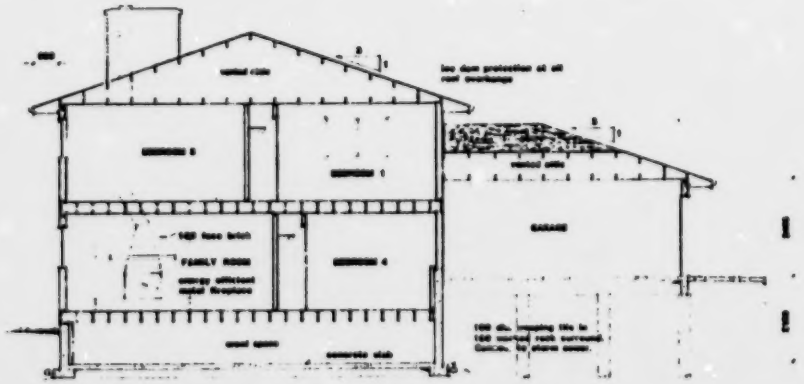
LEFT SIDE ELEVATION

A - 3

2 OF 3



BUILDING CROSS SECTION



BUILDING CROSS SECTION

SPECIFICATIONS

FOUNDATIONS

- 30 Mpa, type 80 concrete in 400 x 200 reinforced concrete footings
- 20 Mpa, type 20 concrete in 300mm up concrete foundation walls c/w 4 rows of #10 rebar
- 20 Mpa concrete basement floor slab 75mm thick over 6 mil poly, and 150mm compacted sand
- 100mm reinforced garage floor on compacted sand
- 100mm dia. reinforced concrete piles under garage floor and grade beam
- 100mm dia. weeping tile c/w sideboom of 100 washed gravel surround
- asphalt emulsion spray applied to interior and exterior of foundation

FRAMING

- floor joists 38 X 235 @ spaces at 400mm o.c. and c/w 38 X 38 cross-bridging
- built-up 3ply beams on adjustable steel posts
- 19mm tongue and groove fir plywood subfloor
- 19mm fir plywood underlay
- exterior walls 38 X 140 SS spaces at 400mm o.c.
- interior partitions 38 X 89 SS spaces at 400mm o.c.
- 12mm "sheetboard" wall sheathing
- pre-engineered wood roof trusses
- 15mm spruce plywood roof sheathing

INSULATION/VAPOUR BARRIER/DRYWALL

- exterior walls R20 glass fibre batts
- wall poly vapour barrier sealed at all joints
- ceilings R40 loose fill glass fibre insulation and 4 mil poly. c/w.
- 12mm gypsum wallboard throughout

EXTERIOR FINISHES

(see building elevations on drawing no. 3)

DOORS AND WINDOWS

- metal insulated front door
- (200) wide aluminum patio door c/w tinted canopy and prefinished aluminum clad fir frames and casings
- hollow core interior doors (variety not determined), stained
- mahogany faced bi-fold closet doors
- aluminum window, c/w vinyl inserts, tinted canopies, and prefinished aluminum clad fir casings
- insulated glass sealed unit in living room window
- 4880 wide X 2100 high wood sectional overhead overhead garage door (painted)

INTERIOR FINISHES

- ceramic tile to bath surround
- hollow doors to cottage
- sheet vinyl flooring in bathroom, kitchen and dining area
- 12mm, 100% nylon carpet with foam strip foam underlay
- paint to walls, latex wood-grain (bathroom, kitchen, dining area)
- oppulent headboards and trim

FITTINGS

- douglas fir plywood shelving with hardwood edging
- bathroom vanity (solid wood)
- kitchen overhead and base cabinets (solid wood)
- hardwood wood railing c/w spindles, railing stock, and newel posts

SPECIALTIES

- all washroom accessories including full-size shower
- mailbox, cabinets
- 24mm dia. chrome shower curtain rods
- mailbox and house numbers
- range hood
- energy efficient 610mm fireplace c/w fan
- oppulent hardware throughout

PLUMBING AND HEATING

- stainless steel double kitchen sink
- vanity sinks
- toilet closets
- fiberglass tub/shower units
- dishwasher rough-in
- 3 plumbing fixtures on third level
- washer stand-pipe
- 3 hose bibbs
- 9.5 imp. gallon (140 litre) water heater (gas fired)
- gas lines, furnace and burners c/w humidifier

ELECTRICAL

- 100 amp, 30 breaker electrical service
- 230 volt electrical service to dryer and range locations
- recessed c/w fluorescent lighting fixture in main bath
- GFI protected plugs in bathrooms
- 3 exterior weatherproof wall plugs
- dishwasher rough-in
- 5 telephone locations
- 2 cable locations
- smoke detectors
- electrical wiring for future garage door opener
- range hood installations
- bathroom fans
- oppulent lighting package
- rough-in central vacuum system

A - 4

APPENDIX B

TECHNICAL DRAWINGS OF SPRINKLER AND SMOKE ALARM SYSTEMS

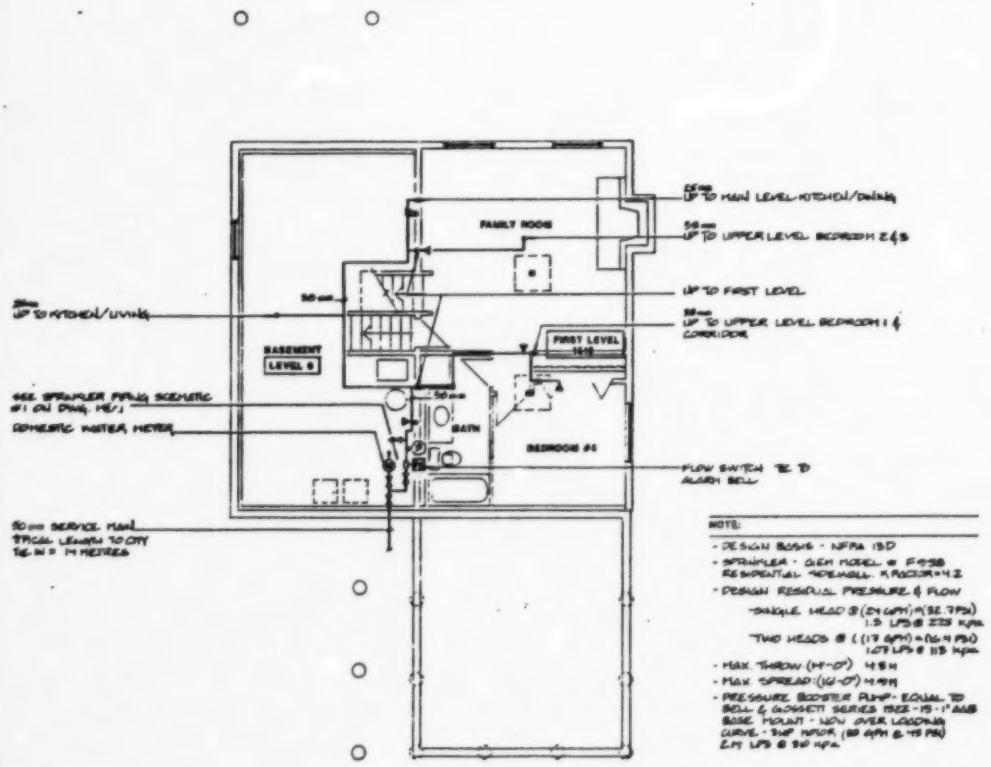
Drawing M-1 Sprinkler Layout - NFPA 13D . . . . . .

Drawing M-2 Modified Sprinkler Layouts. . . . . .

Drawing E-1 Modified Installation of Smoke Alarms . . . . . .

Drawing E-2 Proposed Installation of Smoke Alarms - NFPA 74 . .

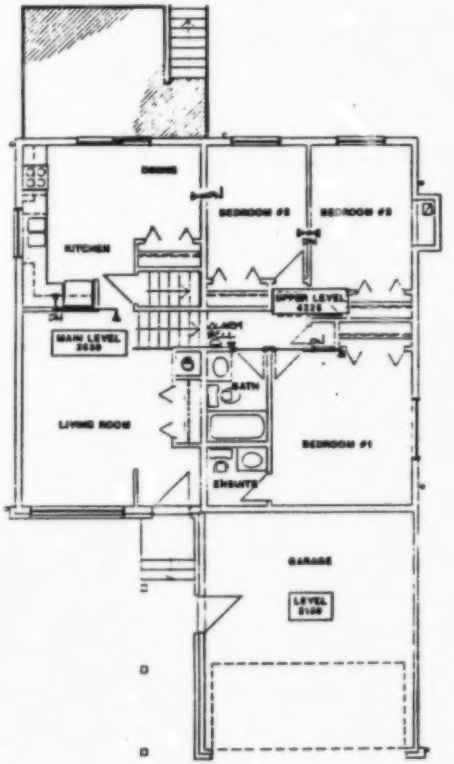
Drawing ME-1 Sprinkler and Alarm System Details. . . . . .


FAMILY ROOM
BASEMENT LEVEL 0
FIRST LEVEL
BATH
BEDROOM #1
50mm UP TO KITCHEN/LIVING
50mm UP TO MAIN LEVEL-KITCHEN/DINING
50mm UP TO UPPER LEVEL BEDROOM #2 & 3
UP TO FIRST LEVEL
50mm UP TO UPPER LEVEL BEDROOM #1 & CORRIDOR
SEE SPRINKLER PIPING SCHEMATIC #1 ON DWG. M2.1
DOMESTIC WATER METER
FLOW SWITCH TO ALARM BELL
50mm SERVICE MAIN TYPICAL LENGTH TO CITY TIE-IN = 14 METRES

BASEMENT/FIRST LEVEL PLAN

NOTE:

- DESIGN BASIS - NFPA 13D
- SPRINKLER - GEM MODEL # F-938 RESIDENTIAL HORIZONTAL K FACTOR = 4.2
- DESIGN RESIDUAL PRESSURE & FLOW
  - SINGLE HEAD @ (24 GPM) = (52.7 PSI) 1.5 LPS @ 225 KPa
  - TWO HEADS @ ((17 GPM) = (26.4 PSI) 1.07 LPS @ 115 KPa
- MAX. THROW (14'-0") 4.9m
- MAX. SPREAD: (10'-0") 4.9m
- PRESSURE BOOSTER PUMP - EQUAL TO BELL & GOSSETT SERIES 1532-15 - 1" ANSI BASE MOUNT - NON OVER LOADING CURVE - 3HP MOTOR (80 GPM @ 45 PSI) 2.71 LPS @ 310 KPa

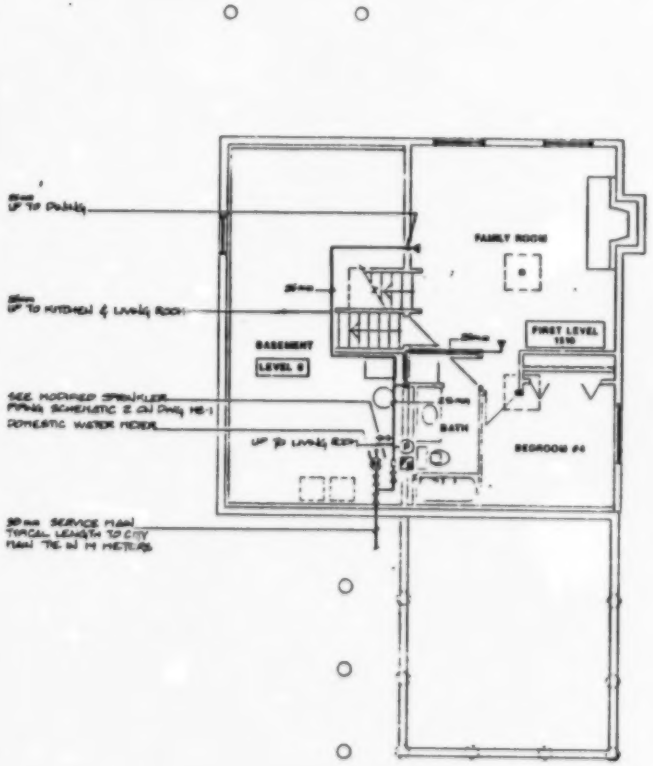


MAIN/UPPER FLOOR PLAN

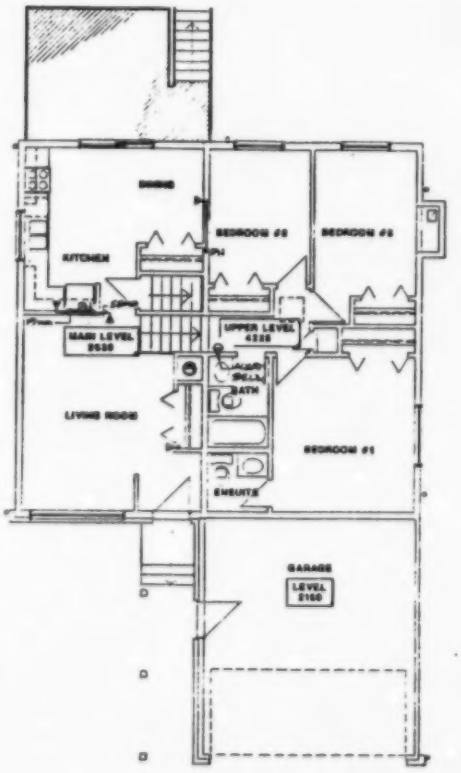
B - 2

DRAWN	BW	SPRINKLER LAYOUTS - NFPA 13D	Project No. 0-13888
DESIGN	JCW	FIRE PROTECTION FOR SINGLE FAMILY RESIDENTIAL HOUSING	Drawing No. M-1
CHECKED	JCW		
APPROVED	JCW		
SCALE	NOTED		
DATE	FEB/89		

welch forest engineering ltd.

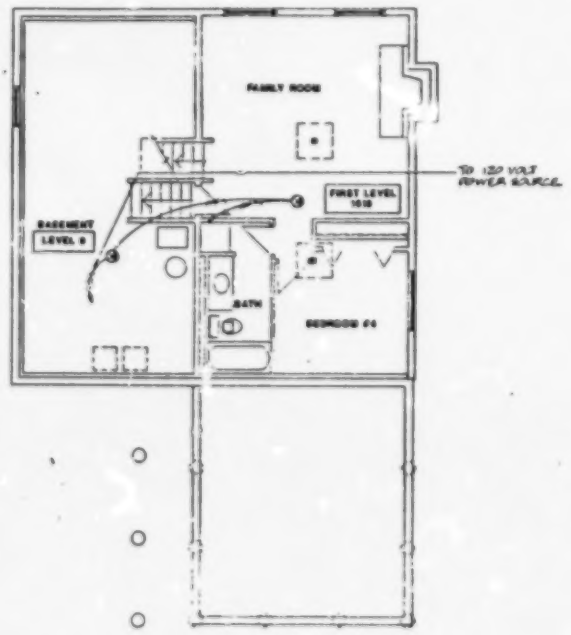


BASEMENT/FIRST LEVEL PLAN

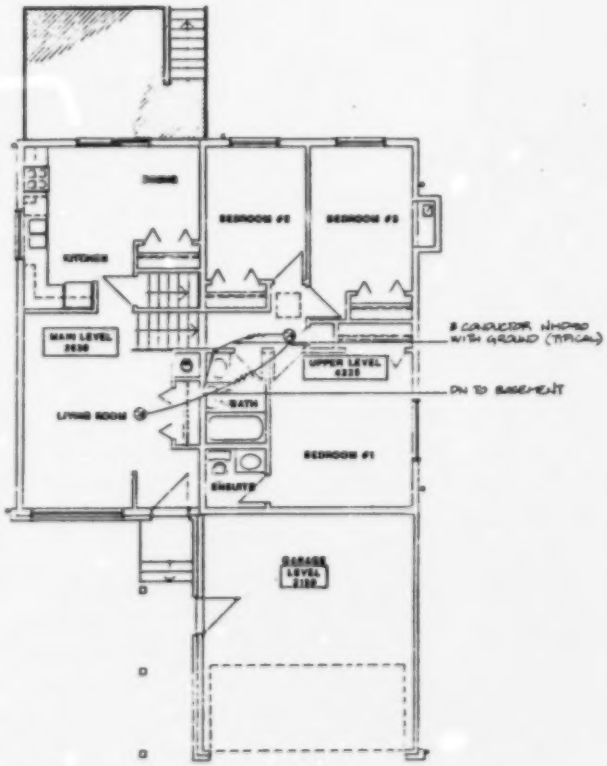


MAIN/UPPER FLOOR PLAN

B - 3



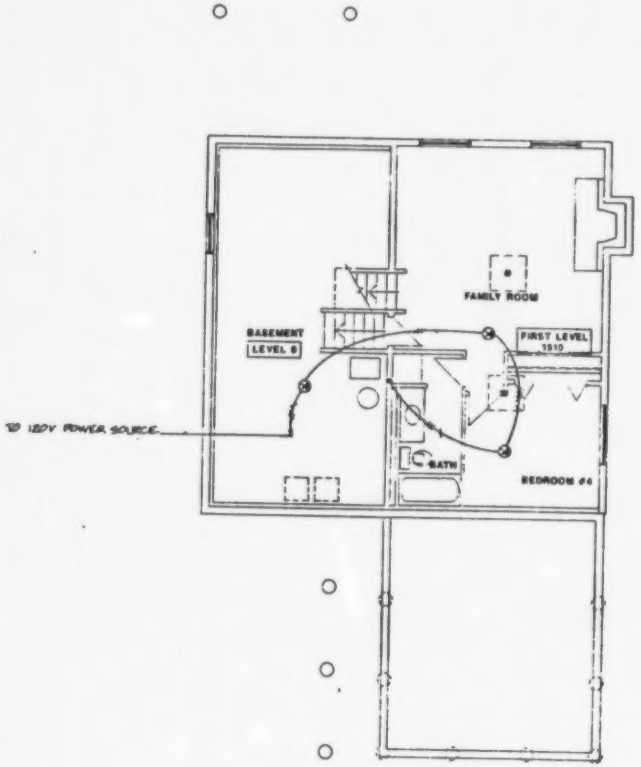
BASEMENT/FIRST LEVEL PLAN



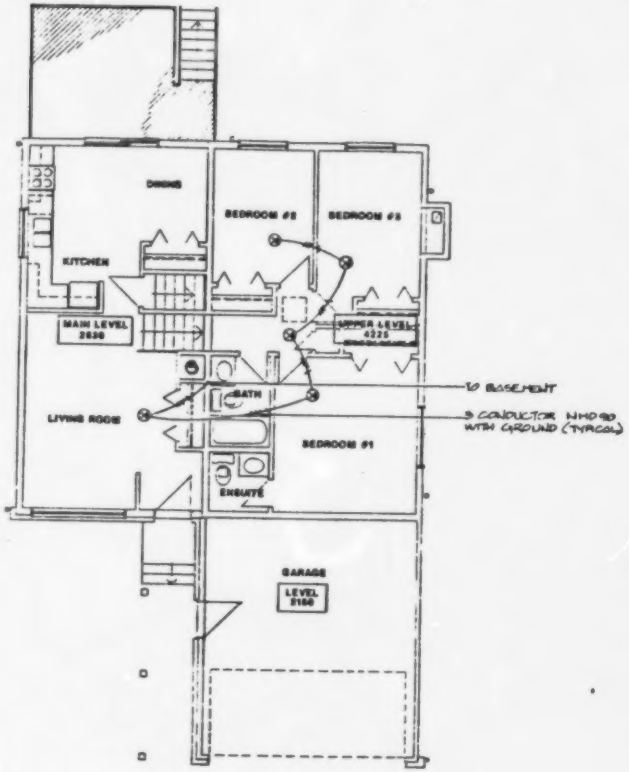
MAIN/UPPER FLOOR PLAN

B - 4

		MODIFIED INSTALLATION OF SMOKE ALARMS	
		FIRE PROTECTION FOR SINGLE FAMILY RESIDENTIAL HOUSING	E-1



BASEMENT/FIRST LEVEL PLAN

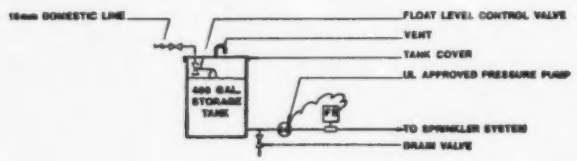


MAIN/UPPER FLOOR PLAN

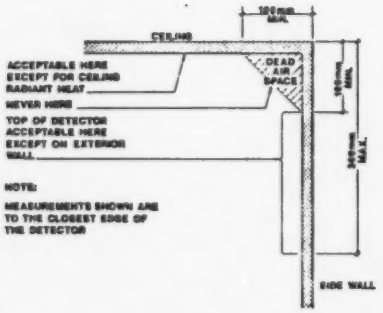
B - 5

DRAWN	BW	PROPOSED INSTALLATION OF SMOKE ALARMS - NFPA 74	
DESIGN	JB		B-13888
CHECKED	JB	FIRE PROTECTION FOR SINGLE FAMILY RESIDENTIAL HOUSING	DRAWING No. E-2
APPROVED	JB		
SCALE	1:50		
DATE	FEB/00		

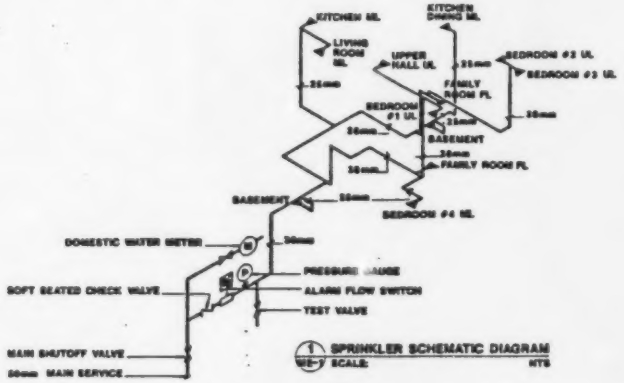
wiebe forest engineering ltd.



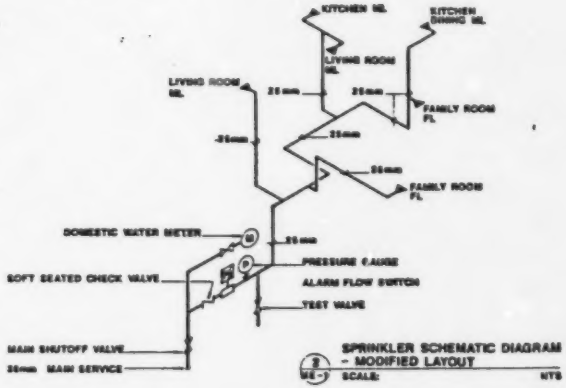
4 ME-1 RURAL RESIDENCE BOOSTER SYSTEM
SCALE: NTS



3 ME-1 SMOKE ALARM MOUNTING DETAIL
SCALE: NTS



1 ME-1 SPRINKLER SCHEMATIC DIAGRAM
SCALE: NTS



2 ME-1 SPRINKLER SCHEMATIC DIAGRAM - MODIFIED LAYOUT
SCALE: NTS

NOTE
FL – FIRST LEVEL
ML – MAIN LEVEL
UL – UPPER LEVEL

THIS DRAWING AND ALL DESIGNS AND INFORMATION SHOWN THEREON ARE THE PROPERTY OF THE CONSULTANT AND SHALL NOT BE REPRODUCED OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE EXPRESS WRITTEN PERMISSION OF THE CONSULTANT

wilcox forest engineering ltd.
MECHANICAL & SPRINKLER DESIGN ENGINEERS

DRAWN	BW
DESIGN	JCW
CHECKED	JCW
APPROVED	JCW
SCALE	1:50
DATE	FEB/00

SPRINKLER AND ALARM SYSTEM DETAILS

FIRE PROTECTION
FOR SINGLE FAMILY RESIDENTIAL HOUSING

Project No. 9-13866
Drawing No. ME-1

APPENDIX C

SPECIFICATIONS FOR

SPRINKLER AND SMOKE ALARM SYSTEMS

WIEBE FOREST ENGINEERING LTD.

MARCH, 1989

FIRE PROTECTION

FOR

SINGLE FAMILY RESIDENTIAL HOUSING

SPRINKLER AND SMOKE ALARMS SYSTEM

- SPECIFICATONS -

WIEBE FOREST ENGINEERING LTD.

FEBRUARY, 1989

1.1 Summary of Work

.1 Requirements Included
.1 Title and description of work: Fire Protection for Single Family Residential Housing.
.2 Contract method: Lump sum bid.

.2 Related Requirements
.1 Section 15330: Wet Pipe Sprinkler System
.2 Section 16722: Residential Smoke Alarms

1.2 Scope of Work

.1 Installation of a Single Family Residential Housing Sprinkler System and all associated work and services.

.2 Installation of a Single Family Residential Smoke Alarm System and all associated work and services.

1.3 List of Drawings

.1 M-1 Sprinkler Layout

.2 M-2 Modified Sprinkler Layout.

.3 E-1 Required Installation of Smoke Alarms.

.4 E-2 Proposed Installation of Smoke Alarms.

.5 ME-1 Sprinkler and Fire Alarm Details.

1.4 Cutting and Patching

.1 Approvals
.1 Submit written request in advance of cutting or alteration which affects:
.1 Structural integrity of any element of Project.
.2 Work of Owner or separate contractor.

.2 Inspection
.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
.2 After uncovering, inspect conditions affecting performance of work.
.3 Beginning of cutting or patching means acceptance of existing conditions.

.3 Execution
.1 Perform cutting, fitting, and patching including excavation and fill, to complete the Work.
.2 Remove and replace defective and non- conforming work.
.3 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical work.
.4 Perform work to avoid damage to other work.
.5 Prepare proper surfaces to receive patching and finishing.
.6 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
.7 Restore work with new products in accordance with Contract Documents.
.8 Fit work airtight to pipes, sleeves, conduit, and other penetrations through surfaces.

1.5 Submittals

.1 Administrative
.1 Submit to Engineer submittals listed for review. Submit with reasonable promptness and in an orderly sequence so as to not cause delay in the work.
.2 Work affected by submittal shall not proceed until review is complete.
.3 Review submittals prior to submission to Engineer. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of the Work and Contract Documents.
.4 Verify field measurements and affected adjacent Work are co-ordinated.

.2 Shop Drawings and Product Data
.1 "Shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of the work.
.2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connection, explanatory notes and other information necessary for completion of Work.
.3 Adjustments made on shop drawings by Engineer are not intended to change Contract Price.
.4 Make changes in shop drawings as Engineer may require.
.5 Submit 6 prints of shop drawings for each requirement requested in specification sections and as Engineer may reasonably request.

.3 Operating Maintenance Manuals
.1 Prior to Substantial Performance of the Work, submit to Engineer, three copies of operating and maintenance manuals.
.2 Manuals to contain operational information on Operation and Maintenance of Sprinkler and Alarm Systems and copies of required Test Certificates.

.3 (Cont'd)
.3 Bind contents in a three-ring, hard covered, plastic jacketed binder. Organize contents into applicable categories of work, parallel to specifications sections.

1.6 Quality Control

.1 Inspection
.1 Owner and Engineer shall have access to the work.
.2 Give timely notice requesting inspection if work is designated for special tests, inspections or approvals by Consultant instructions, code or local authority requirements.
.3 If Contractor covers or permits to be covered work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.

.2 Independent Inspection Agencies.
.1 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Reports
.1 Submit 1 copy of inspection and test reports promptly to Engineer.
.2 Provide copies to include in Maintenance Manual.

1.7 Material and Equipment

.1 Product and Material Quality
.1 Products, materials, equipment and articles (referred to as Products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
.2 Defective Products, will be rejected, and replaced at no cost to Owner.

.2 Manufacturer's Instructions
.1 Unless otherwise indicated in specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
.2 Notify Engineer in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant may establish course of action.
.3 Improper installation of erection of Products, due to failure in complying with these requirements, authorizes Consultant to require removal and reinstallation at no increase in Contract Price.

.3 Workmanship
.1 Workmanship shall be best quality, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Engineer if required work is such as to make it impractical to produce required results.

.4 Concealment
.1 In finished areas, conceal pipes, ducts and wiring in floors, and walls except where indicated otherwise.
.2 Before installation, inform Engineer if there is a contradictory situation. Install as directed by Consultant.

1.8 Project Closeout

.1 Final Cleaning
.1 Refer to GC30.
.2 When the Work is Substantially Performed, remove surplus products, tools construction machinery and equipment not required for performance of remaining Work.
.3 Leave work clean before inspection process commences.

.2 Systems Demonstration
.1 Prior to final inspection, demonstrate operation of each system to Owner.
.2 Instruct Owner in operation, and maintenance of equipment and systems, using provided operation and maintenance data as basis for instruction.

.3 Documents
.1 Collect reviewed submittals and assemble documents executed by Subcontractors, suppliers, and manufacturers.
.2 Submit material prior to final Application for Payment.
.3 Submit operation and maintenance data.
.4 Provide warranties and bonds.

1.9 Guarantees

.1 Provide written guarantee for labour and material for a period of one year from date of Substantial Completion.

1.10 Tender Cost and Cost Breakouts

.1 The tender prices shall include the following base costs and cost breakouts:
.1 50 mm - domestic and fire protection water service based on 14 meter service length located in Calgary: $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.1 (Cont'd)

.2 19 mm - standard domestic water service based on a 14 meter service length located in Calgary: $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.3 Reference Drawing M-1 and ME-1 Installation of a Single Family Residence Sprinkler System in compliance with NFPA-13D : $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.4 Reference Drawing M-2 and ME-1 Installation of a modified Single Family Residence Sprinkler System: $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.5 Reference Drawing E-1 and ME-1 Installation of Smoke Alarm System in accordance with NFPA-74 : $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.6 Reference Drawing E-2 ME-1 Installation of Smoke Alarm System in accordance with Alberta Building Code : $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

.7 Reference Drawing ME-1 Installation of a water storage tank and pressure pump for use with private water systems : $ _____
Overhead and Profit: $ _____
Total Tender Price: $ _____

---------- END ----------

PART 1 - GENERAL

1.1 Related Work

.1 Section 01001: General Requirements

.2 Division 16: Electrical.

1.2 Reference Standards

.1 Do work in accordance with the following except where specified otherwise.
.1 Alberta Building Code (1985).
.2 NFPA 13D - Sprinkler Systems in one and two family dwellings and mobile homes.

1.3 Shop Drawings

.1 Submit shop drawings and product data in accordance with Section 01001 - General Requirements and NFPA 13D, working plans and design requirements.

1.4 Certificates

.1 Provide certification at the completion of the project that the sprinkler system is installed in compliance with applicable reference standards including the Alberta Building Code.

1.5 Engineering Design Criteria

.1 Design system to NFPA 13D using following parameters:
.1 Hazard:
.1 Residential.
.2 Pipe size and layout:
.1 Hydraulic design for sprinkler system.
.2 Head layout: to NFPA 13 and as indicated.
.3 Water supply:
.1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for basis of design in accordance with NFPA 13D.
.2 For the purposes of tendering only, base design on NFPA 13D and water flow rate of 2.14 L/s and residual pressure of 310 kPa at location.

.1 Design system to NFPA 13D using following parameters: (Cont'd)
.4 Zoning:
.1 System zoning as indicated.

1.6 Maintenance Data

.1 Provide maintenance data for incorporation into manual specified in Section 01001 - General Requirements.

1.7 Maintenance Materials

.1 Provide spare sprinklers and tools as required by NFPA 13D in cabinet in furance room.

PART 2 - PRODUCTS

2.1 Pipe, Fittings and Valves

.1 Pipe:
.1 Ferrous: to NFPA 13D.
.2 Copper tube: to NFPA 13D.

.2 Fittings and joints:
.1 Screwed, soldered, to NFPA 13D.

.3 Valves:
.1 ULC listed for fire protection service.
.2 Bronze to NPS 2.
.3 Threaded to NPS 2.
.4 For shut off service: OS & Y gate.
.5 Swing check soft seated valves.

.4 Pipe hangers:
.1 To NFPA Standard.

2.2 Sprinkler Heads

.1 General: to NFPA 13D and ULC listed for Residential Quick Response fire service.

2.3 Sprinkler Head Type

.1 Side wall chrome link and lever type.
.1 Standard of Acceptance: Gem Model F-958.

2.4 Supervisory Switches

.1 Flow Switch:
- .1 With N.O. and N.C contacts and supervisory capability.
- .2 With adjustable time delay.

2.5 Alarm Bell

.1 To NFPA 13 and ULC-S525-1978: surface mounted, vibrating under dome, steel alloy bell, 150 mm diameter, 120 vac, 92 dB output at 3 m on axis.

2.6 Pressure Booster Pump

.1 Pumps: Centrifugal direct drive, non overloading, as indicated.

.2 Motor: EEMAC Class B squirrel cage induction 3450 rpm, continuous duty, drip proof, ball bearing, maximum temperature rise 50 Deg.C.

.3 Capacity: Flow 2.14 Lps.

.4 Pump Operation Switch: to operate pressure pump with pressure of 310 kPa.

.5 Electrical wiring by Division 16.

2.7 Signs

.1 Signs for control, drain and test valves: to NFPA 13.

PART 3 - EXECUTION

3.1 Installation

.1 Install and test to acceptance in accordance with NFPA 13D.

.2 Install pressure booster pump and storage tank in accordance with manufacturer's instructions and as indicated for rural and private water system installations.

.3 Testing to be witnessed by authorities having jurisdiction.

---------- END ----------

PART 1 - GENERAL

1.1 Description of System

.1 System includes smoke alarms as indicated on the drawings designed to provide early fire detection and sound alarm signal in case of products of combustion being detected.

1.2 Requirements of Regulatory Agencies

.1 To requirements of local authority having jurisdiction.

.2 To Alberta Building Code 1985 and associated Standata.

.3 To NFPA 74-1984: Household Fire Warning Equipment.

.4 To Canadian Electrical Code, Part I, Section 32 and provincial amendments.

1.3 Shop Drawings

.1 Submit shop drawings of smoke alarms proposed to be installed, prior to ordering.

1.4 Operation and Maintenance Data

.1 Provide complete operation and maintenance data for incorporation into maintenance manual for Owner.

.2 Include in manual:
.1 Instructions detailing typical installation layouts.
.2 Description of operation, required maintenance and minimum testing intervals.
.3 Information for establishing a household evacuation plan.
.4 Information on where the Owner may obtain repair or replacement service and parts.

PART 2 - PRODUCTS

2.1 Wiring and Outlet Boxes

.1 Power supply wiring: 14 AWG copper, NMD90 non-metallic sheathed cable.

.2 Interconnection wiring: approved Class 2 wiring may be used, minimum 18 AWG copper. Note that extra-low-voltage control cable, such as LVT, is rated 30 volts maximum and is not permitted to enter boxes containing conductors connected to circuits of a higher voltage. NMD90 may also be used for smoke alarm interconnection.

.3 Outlet boxes: 102 mm octagonal electro-galvanized with two double clamps to accept non-metallic sheathed cable.

2.2 Smoke Alarms

.1 Smoke alarms: to ULC-S531-1978.
.1 Ionization type, dual chamber. Responds to visible and invisible products of combustion.
.2 Humidity and temperature compensated.
.3 120 Vac operation.
.4 85 dB audible alarm, solid state type.
.5 Integral red operating lamp.
.6 Sensitivity test button.
.7 Auxiliary lead for interconnection for up to 8 smoke alarms.
.8 Continuous alarm signal to sound when unit senses products of combustion, interrupted alarm on interconnected units.

.2 Neither loss nor restoration of power shall cause an alarm signal.

PART 3 - EXECUTION

3.1 Installation

.1 Install smoke alarms in accordance with requirements of regulatory agencies as listed in 1.2 above.

.2 Locate and install smoke alarms flush mounted where indicated, on or near the ceiling, and connect to power supply and interconnecting alarm circuit wiring.

.3 Install smoke alarms a minimum of 100 mm from walls and other vertical projections, and 600 mm from supply air diffusers. Coordinate with other trades.

.4 Install smoke alarms at the high side of the room in areas with a ceiling slope of greater than 1 m in 8 m.

.5 Do not install smoke alarms on exterior walls, or on ceilings that contain a radiant heating source.

.6 A smoke alarm installed in a stariway shall be located to ensure that smoke rising in the stairway cannot be prevented from reaching the device by an intervening door or other obstruction.

.7 Do not install smoke alarms in close proximity to areas that normally can produce smoke or high humidity, such as kitchens, showers and fireplaces, to reduce false alarming.

3.2 Wiring

.1 Power supply wiring to smoke alarms may be made with 14 AWG NMD90 non-metallic sheathed cable in buildings of combustible construction. Take power for smoke alarms from any single phase 120 volt lighting circuit. Do not take power from any circuit that is protected by a ground fault circuit interrupter.

.2 Wiring methods shall be in accordance with Canadian Electrical Code, Part I, Section 32. Stranded wire, if used, shall be terminated on screws using spade lugs.

.3 Ensure no disconnecting means, such as a light switch, is installed between the power supply and the smoke alarm.

3.3 Tests

.1 Test each and every smoke alarm installed to verify it is functioning as intended. Test devices using an approved aerosol smoke particle generator. Testing using only the test button on the smoke alarm is not allowed.

.2 When each smoke alarm is tested, verify that each interconnected smoke alarm is properly activated.

.3 Ensure that Owner is made aware that battery powered smoke alarms must be tested weekly, and that 120 volt smoke alarms must be tested monthly, in accordance with NFPA 74.

---------- END ----------